

Fig. 1

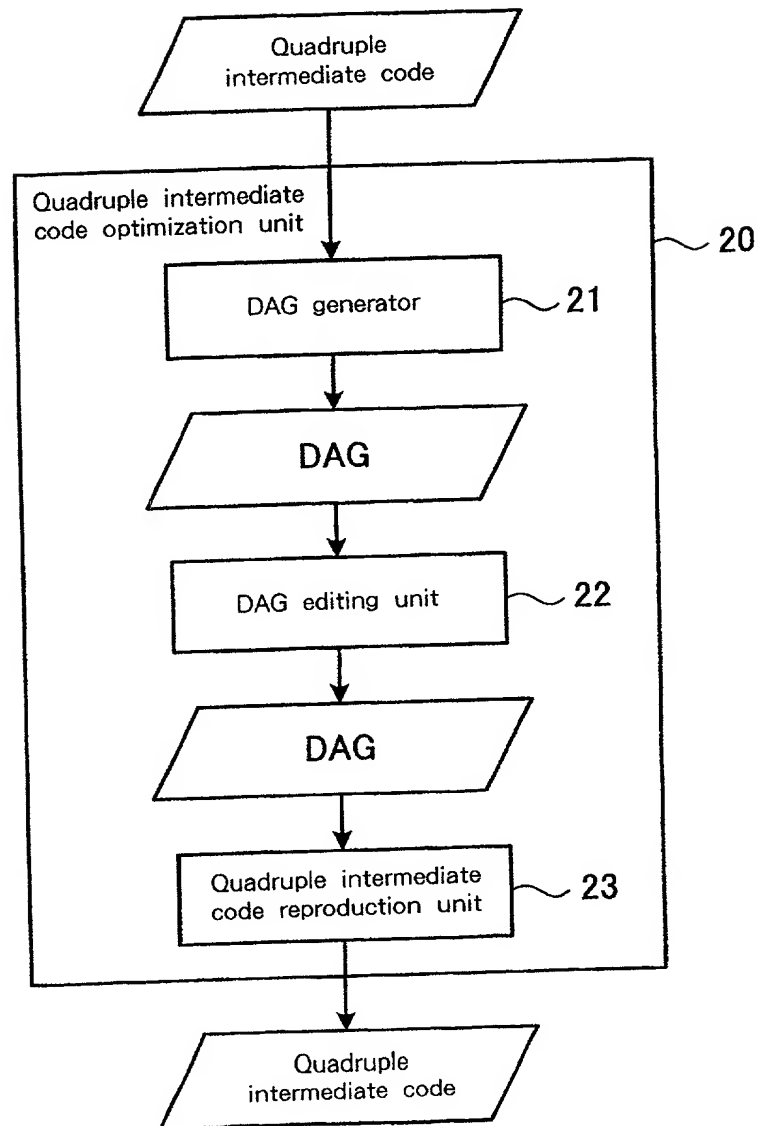


Fig. 2

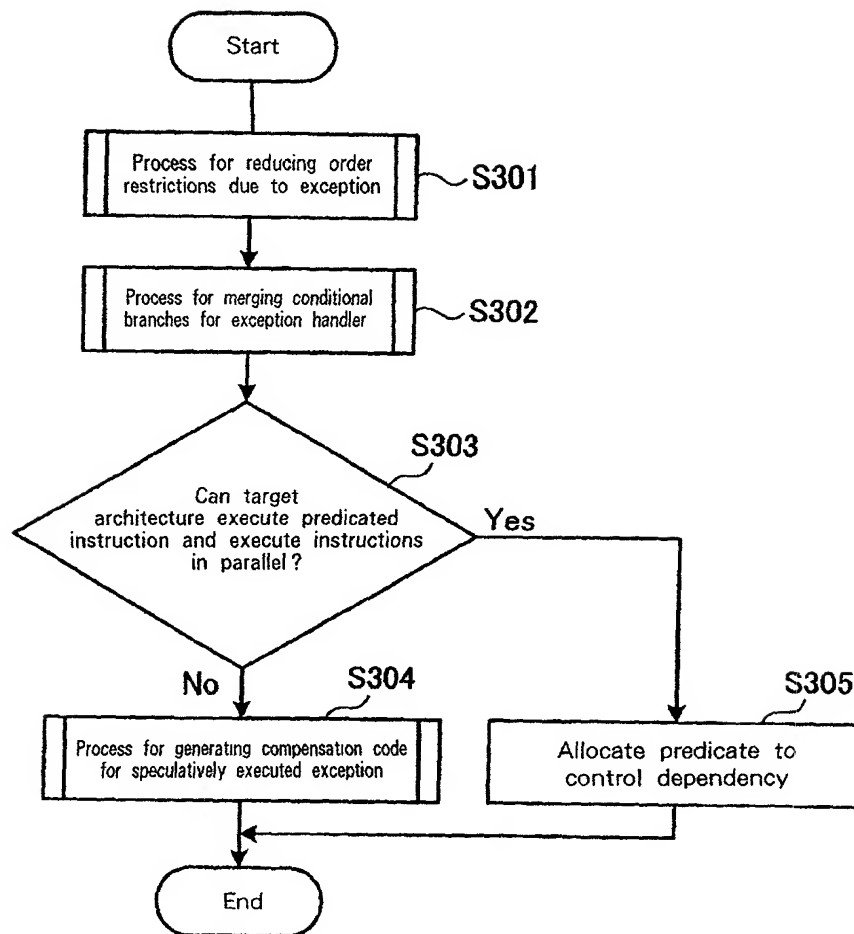


Fig. 3

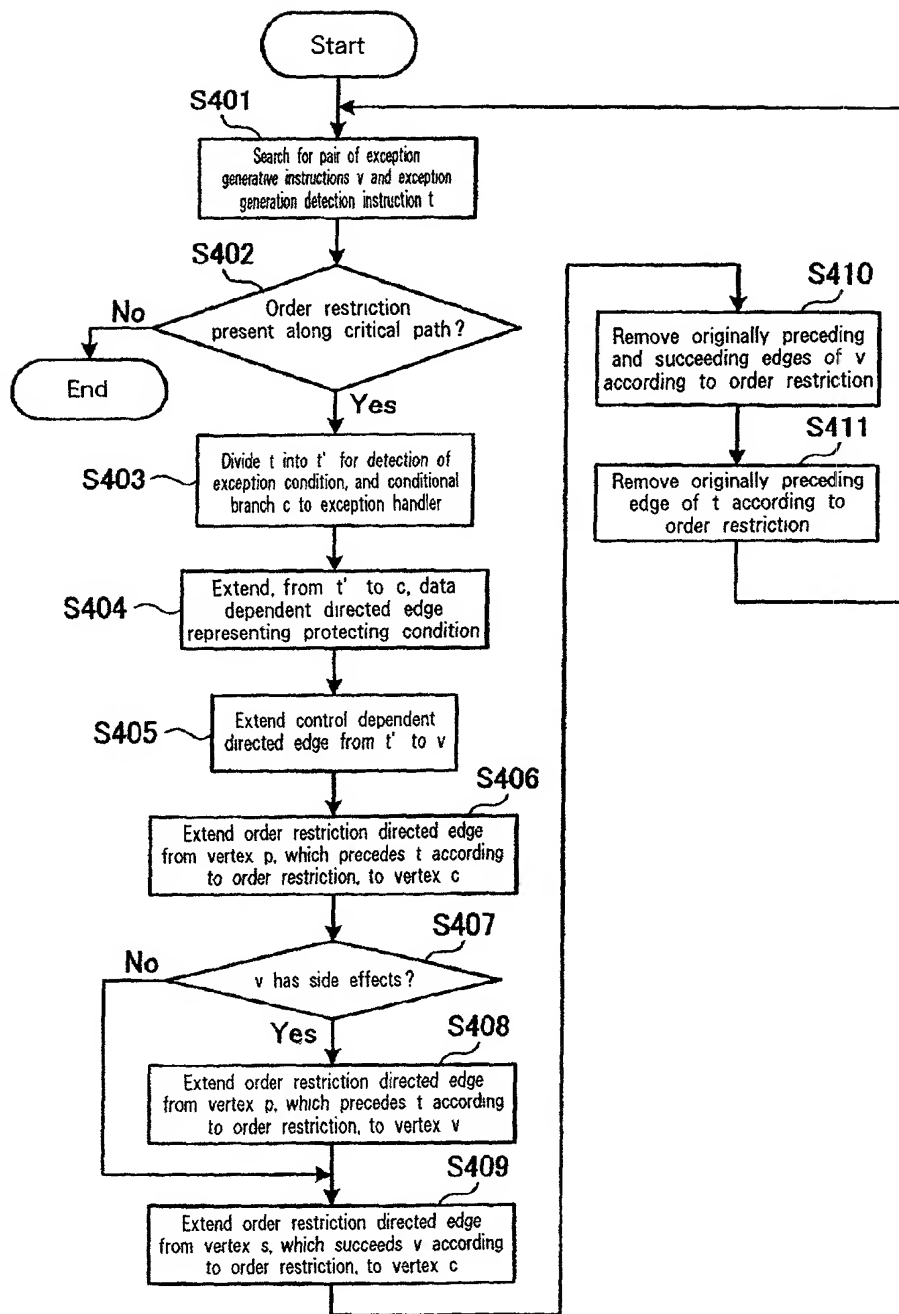


Fig. 4

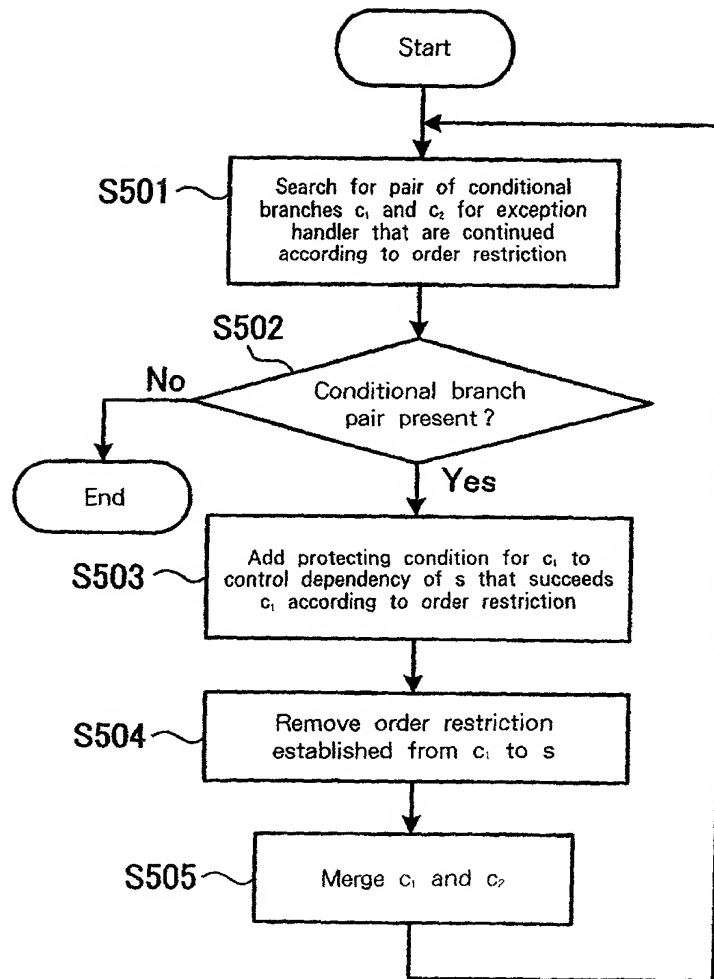


Fig. 5

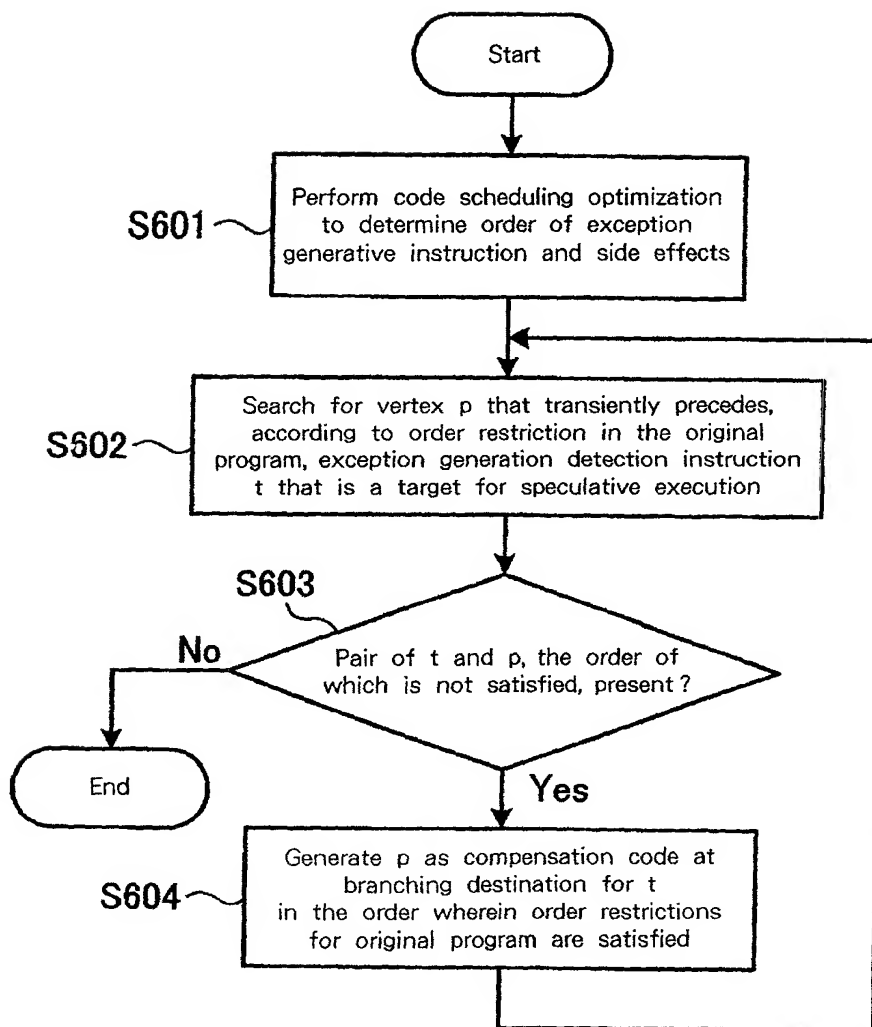


Fig. 6

(A)

```
double test (double a[], double b[], int i, int j) {  
    return a[i] + b[j];  
}
```

(B)

NULL		a
LENGTH	t=	a
SIZE		t, j
LOAD	x=	a, j
NULL		b
LENGTH	t=	b
SIZE		t, k
LOAD	y=	b, k
ADD	z=	x, y

Fig. 7

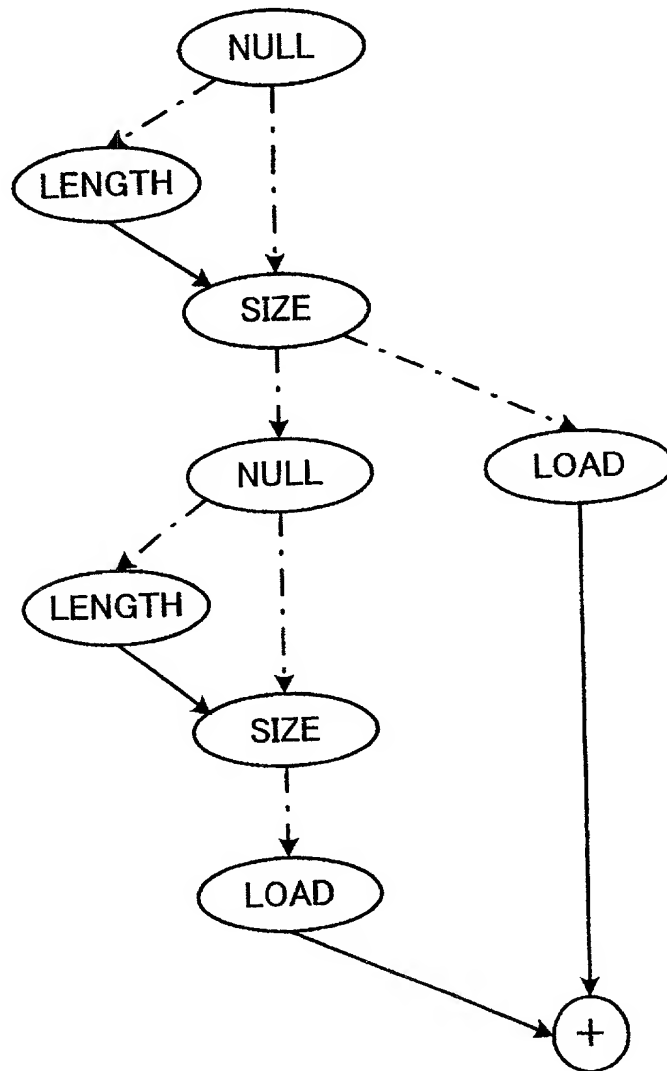


Fig. 8

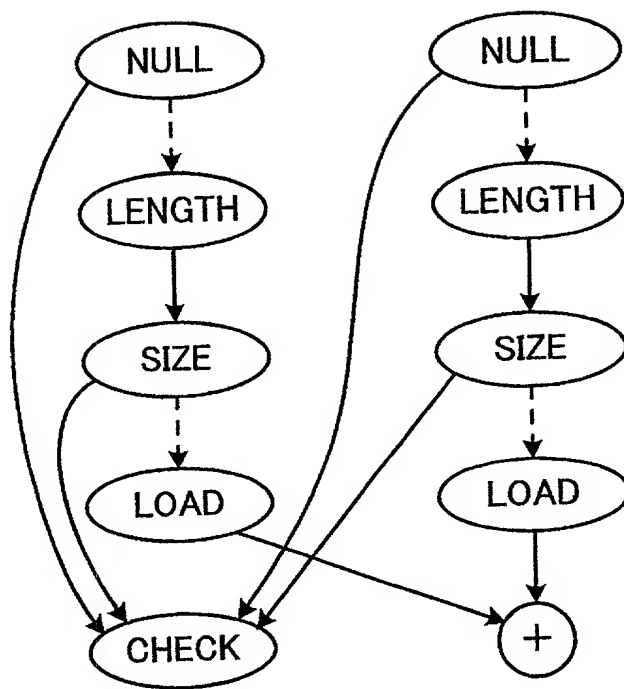


Fig. 9

(A)

```
void    test    (double a[], double b[], double c[],
                  int i, int j, int k)  {
    a[i] = b[j] + c[k];
}
```

(B)

NULL		b
LENGTH	t=	b
SIZE		t, j
LOAD	x=	b, j
NULL		c
LENGTH	t=	c
SIZE		t, k
LOAD	y=	c, k
ADD	z=	x, y
NULL		a
LENGTH	t=	a
SIZE		t, i
STORE		a, i, z

Fig. 10

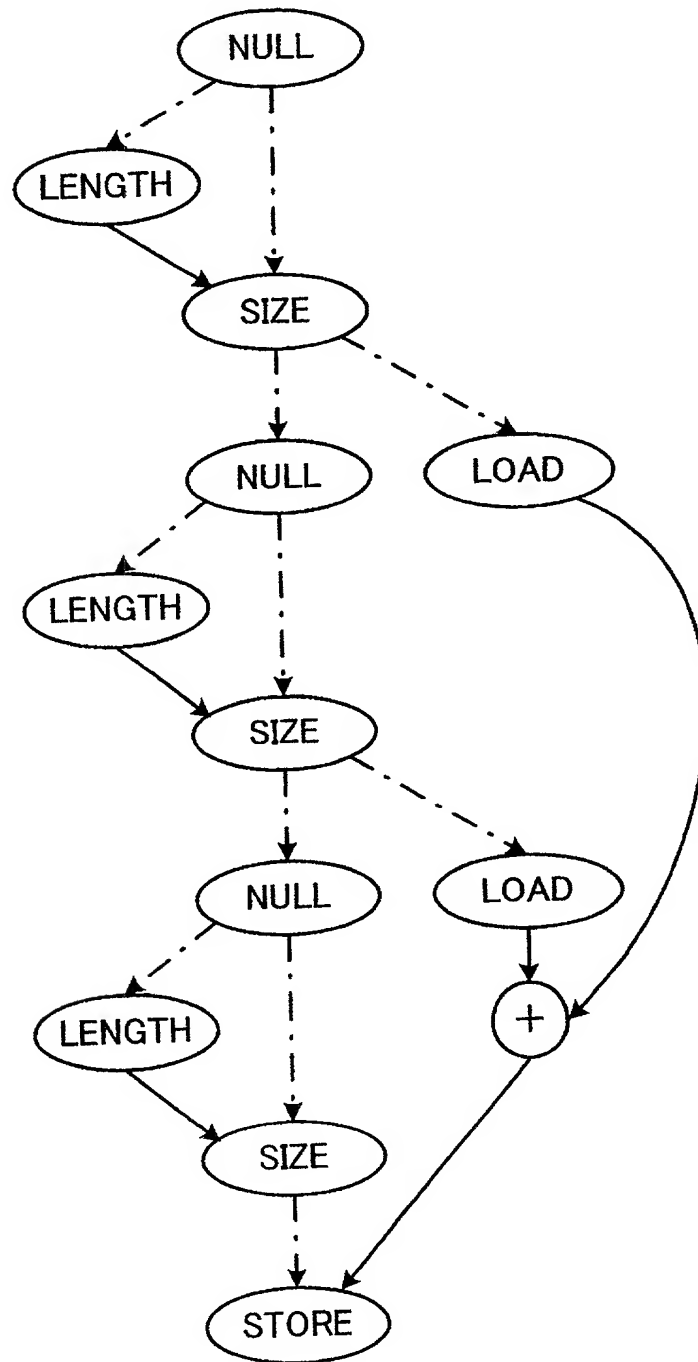


Fig. 11

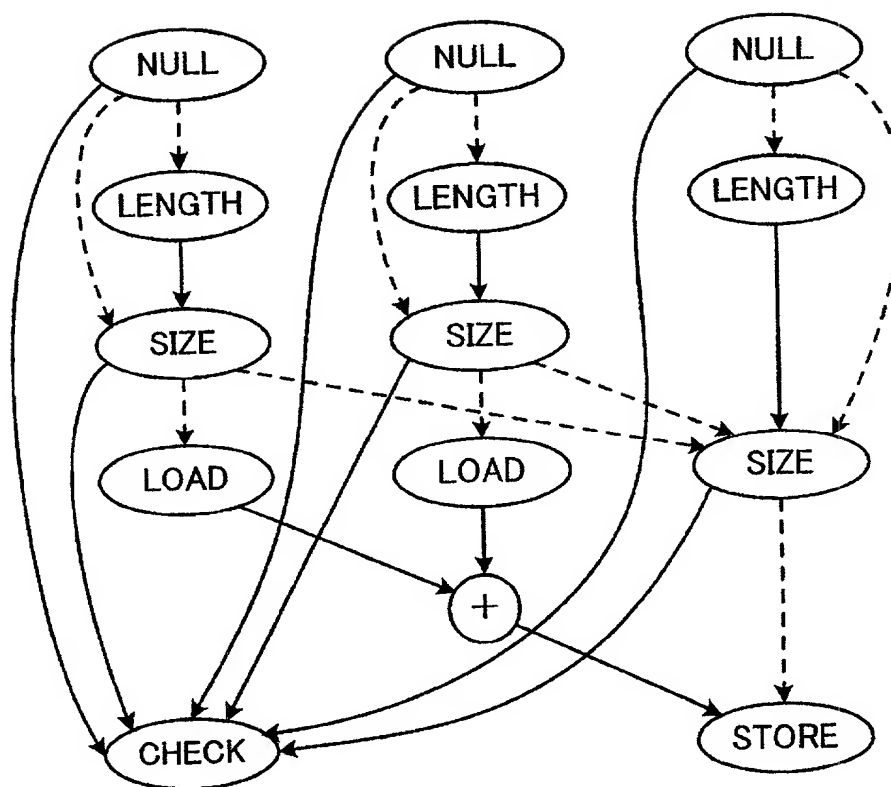


Fig. 12

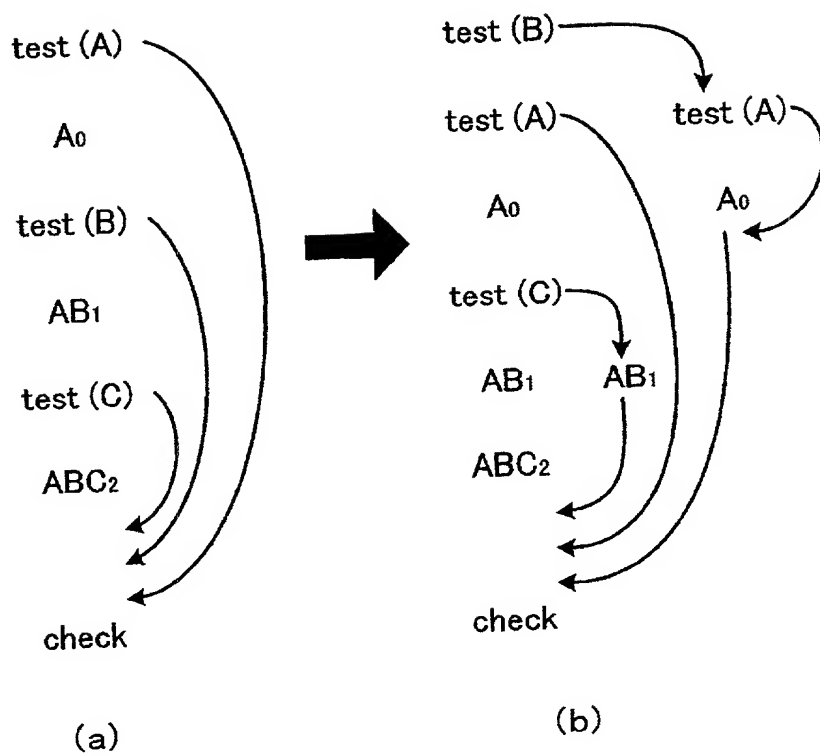


Fig. 13

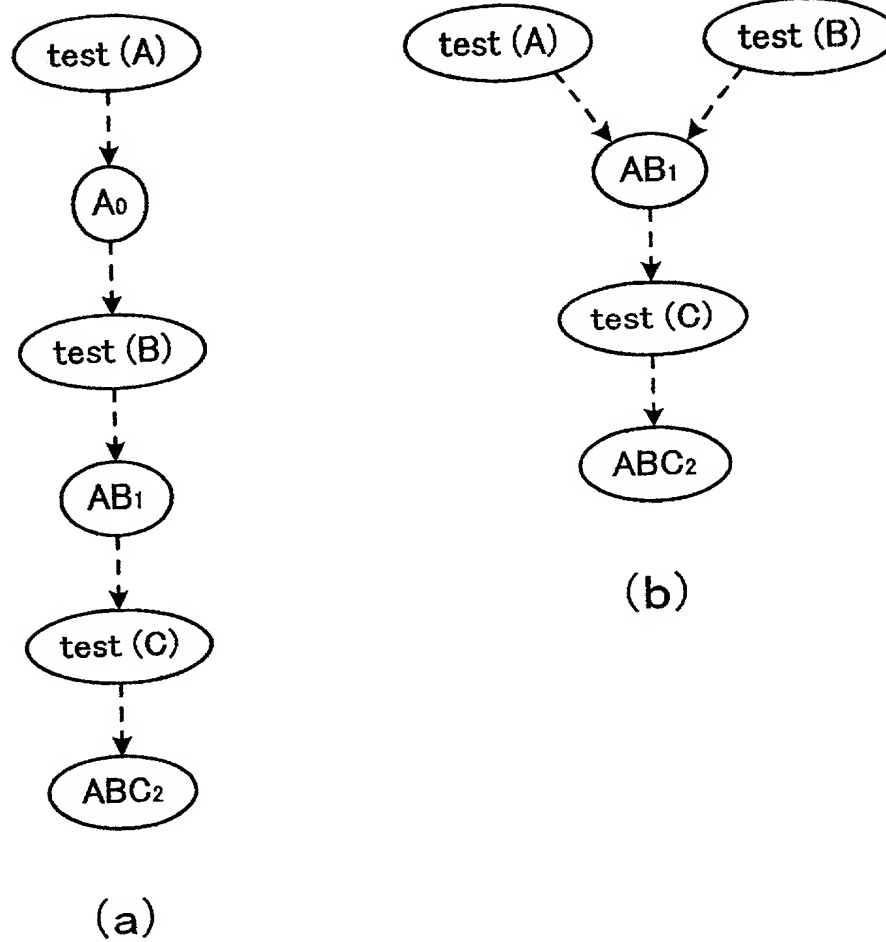


Fig. 14

	NullPointerException	ArrayIndexOutOfBoundsException	Check of representative flag
Normal execution	None	<code>cmp idx, [arrh] jae ehHandler</code>	None
Speculative execution	<code>cmp arrh, 00h jeq flHandler</code>	<code>cmp idx, [arrh] jae flHandler</code>	<code>cmp flag, 00h jne selHandler</code>

Fig. 15

Input

- V : A set of vertexes corresponding to quadruple operators
- E : A set of edges corresponding to the dependency between operators
- $G(V, E)$: DAG representing a program
- $\tau \in V$: Virtual vertex (top) preceding all operators with no preceding operator
- $\perp \in V$: Virtual vertex (bottom) succeeding all operators with no succeeding operator
- $cy(v)$: The number of machine cycles required for the execution of an operation at vertex v
- $cp(G)$: The critical path length of a DAG representing a program when the order restriction due to an exception is ignored

Procedures (calculation of the slackness of a vertex)

$lb(v)$: The level of vertex v from the bottom when the order restriction due to an exception is ignored

1. $lb(v)=0$ when there is no succeeding vertex
2. When there is a succeeding vertex,

$$lb(v) = \max (lb(s)) + cy(v),$$

where $s \in succ(v)$ for a set of vertexes that due to exception succeed v along the edge other than the order restriction edge

$lt(v)$: The level of vertex v from the top when the order restriction due to an exception is ignored

1. $lt(v)=0$ when there is no preceding vertex
2. When there is a preceding vertex,

$$lt(v) = \max (lt(p) + cy(v)),$$

where $p \in pred(v)$ for a set of vertexes that due to exception precede v along the edge other than the order restriction edge

$sl(v)$: The slackness of vertex v when the order restriction due to an exception is ignored

$$sl(v) = cp(G) - lt(v) - lb(v).$$

Fig. 16

	NullPointerException	ArrayIndexOutOf BoundsException	Check of representative flag
Normal execution	tlci arrh, 00h	lw len, [arrh] tlci idx, len	None
Speculative execution	cmp arrh, 00h beq flHandler	lw len, [arrh] cmpl idx, len bgt flHandler	bne cr2, selHandler

Fig. 17

	NullPointerException	ArrayIndexOutOf BoundsException	Check of representative flag
Normal execution	dmp.ne p1, p2 = 00h, arrh (p1) br eHandler	lds len = [arrh] cmp.ltu p1, p2 = idx, len (p1) br eHandler	None
Speculative execution	cmp.ne.and p1,p2 = 00h, arrh	lds len = [arrh] cmp.ltu.and p1, p2 = idx, len	(p1) br selHandler

Fig. 18